Petrie, and measured by Mr. Warren. The modern populations occupying the same districts of Europe as Palæolithic and Neolithic man appear to be taller, but in the case of both south Germany and France there appears to be a slight, but sensible, decrease of stature since prehistoric times. Modern English do not seem to have decreased in stature since the ancient Anglo-Saxons. In the estimates of stature for the above races, the author differs, in some cases very considerably, from previous writers.

9. Beyond the range of normal population (say from 157 to 175 cm. for ♂), the line of regression ceases to be linear. An attempt is made, such as existing data will allow of, to express the line of regression by the equation to a curve. The constants of this curve are determined for measurements of the four chief long bones, and the results exhibited in a diagram, from which it is possible to deduce the probable stature corresponding to a given length of any long bone by inspection. The prediction of the stature of dwarfs from the curve obtained from the data of giants shows only 2·25 cm. mean error, and must be considered satisfactory. Application is then made of the results to reconstruct the stature of Bushmen, Andamanese, and Akkas. These give sufficiently good results to lead us to believe that a fair estimate can be made of the stature of European neolithic dwarfs.

The memoir concludes with a table of reconstructed statures and sexual ratios.

"The Nature of the Antagonism between Toxins and Antitoxins." By C. J. Martin, M.B., D.Sc. Lond., Acting Professor of Physiology, and Thomas Cherry, M.D., M.S. Melb., Demonstrator and Assistant Lecturer in Pathology in the University of Melbourne. Communicated by W. D. Halliburton, F.R.S. Received May 7—Read June 9, 1898.

In the 'Deutsche Med. Wochenschrift' for 1894 appeared a controversy on this subject between Behring and Buchner. Behring maintained that the antagonism was of a chemical nature, and that the antitoxin neutralised the toxin much as an alkali neutralised an acid. Buchner, on the other hand, adduced results opposed to this view, pointing to the interpretation that the action was an indirect one, due to the antitoxin operating in some indirect way through the medium of the cells of the organism. Since this controversy many investigations have been made with the object of deciding this fundamental point. At the present time, however, opinion is still divided;

Behring, Ehrlich, and Kanthack being principal exponents of the direct chemical view, whilst Buchner, Roux, and Metchnikoff still maintain that the interaction takes place only through the intervention of some cells in the body.

We will briefly review the more important observations which bear directly upon the subject of our paper.

(1) *Observations favouring the Interpretation that the Action of Antitoxins is indirect.*

Calmette* in 1895 made experiments with the toxin of cobra poison and its antitoxin, which he had recently succeeded in producing. Cobra poison is not apparently attenuated by heating its solutions to 68° C. for ten minutes. The antitoxin is, however, completely destroyed by this treatment. Mixtures of cobra poison and antitoxin which produced no symptoms when injected into a rabbit, killed similar rabbits in a few hours if after the mixture had remained in contact for ten minutes it were heated for another ten minutes to 68° C. before injecting. From his experiments Calmette concluded that the toxin of snake venom does not interact with its antitoxin *in vitro*, but only *in corpore*, and therefore that its action cannot be explained as a simple chemical operation between the two.

Wassermann† found that the toxin produced by the bacillus pyocyaneus was not destroyed by boiling, whereas its antitoxin was. The amount of toxin and antitoxin which neutralised each other was first determined by experiment, then the same quantities and proportions of these substances were allowed to remain in contact and afterwards heated to boiling. The animals receiving an injection of this heated mixture died, whereas the control animals which received an equal dose unheated recovered. From these experiments Wassermann concluded that the toxin of pyocyaneus does not interact with its antitoxin *in vitro*, but only *in corpore*, and therefore that it cannot be explained as a simple chemical operation between the two.

Nikanorow‡ discovered that the precipitate formed by the addition of a 1 per cent. solution of cupric acetate was possessed of antitoxic properties and the filtrate not. A 1 per cent. solution of cupric acetate does not, however, precipitate the toxin. Mixtures of the two could thus be separated by the use of this reagent. Experiments conducted along the lines mentioned in the experiments above led to identical results.

Marenghi§ made some observations with the toxin and antitoxin

* 'Ann. de l'Inst. Pasteur,' 1895, p. 250.

† 'Zeits. f. Hyg.,' 1896, B. 22, p. 263.

‡ 'Wratsch,' 1896, vol. 31, abstracted 'J. Ph. Chem.,' 1896, p. 983.

§ 'Centralbl. f. Bakt.,' 1897,' vol. 22, p. 521.

of diphtheria which were identical in principle with those of Calmette and Wassermann. In this case, however, it is the toxin which is destroyed at the lower temperature (60° C. Roux and Yersin), whereas the antitoxic properties still remained after heating the serum to 70° C. Mixtures of the two in such proportions as to cause no symptoms when injected into a guinea-pig were made. After heating such mixture to a temperature sufficient to destroy the toxin, the mixture was discovered now to possess antitoxic properties which could be titrated against a fresh amount of toxin.

2. *Observations favouring the interpretation that the action of Antitoxins is direct.*

The view that the operation is a direct one has always received support from the general truth of the "law of multiples," on which indeed the antitoxin notation has been founded. It is further strengthened by the observations of Kanthack and Ehrlich.

Kanthack,* in 1896, demonstrated that the influence of cobra poison in preventing the coagulation of *shed* blood, observed by Cunningham, was prevented by the previous admixture of some of Calmette's antivenomous serum to the solution of cobra poison.

Ehrlich† found that if a solution of ricin, be added to defibrinated blood (? animal) the corpuscles are precipitated in a clump. A ricin solution of the same strength, but containing a little serum from an animal immunised against ricin, failed to produce this result.

Within the last few days we have received a short account of some experiments by Stephens and Meyers,‡ bearing upon the same point. Cobra poison exercises a hæmolytic action upon blood *in vitro*. After admixture of the poison with antivenomous serum this hæmolytic action was absent. The necessary precaution of making the solution of the venom with saline solution approximately isotonic with blood serum was taken.

Before relating the results of our own experiments we may point out one source of fallacy in the conclusions drawn by Wassermann, Calmette, Nikanorow, and Marenghi, viz., that they take no account of the factor, *time*, which may be a very important element in any possible chemical interaction between toxins and antitoxins. Every chemical reaction has a certain definite velocity coefficient, and the rapidity of action under any circumstances where the reacting compounds are in solution depends upon this coefficient, and also upon

* Demonstrated at meeting of Physiol. Soc., October 1896 (not published in Proceedings).

† 'Fortschr. d. Med.,' 1897, No. 2.

‡ "Report of Proceedings of Path. Soc. of London," 'Lancet,' March 5, 1898, p. 644.

the product of the active masses of the reacting bodies present. Temperature will also exercise an important influence.

As we shall later show, the experiments quoted by these observers can easily be repeated and the same results obtained. Nevertheless their conclusions are quite unjustified, and by modification of the factors, *time*, *temperature*, and *active masses*, exactly opposite results may also be obtained.

Experimental results obtained by the Authors.

Our experiments have been conducted with the toxin of diphtheria, and one of the constituents of the poison of the Australian tiger snake (*Hoplocephalus curtus.*)

The diphtheria toxin was prepared by cultivating the organisms in broth made from well hung beef, after the method of Spronck.* It was filtered through a sound Pasteur-Chamberland filter, and the toxin strength of the filtrate determined by injection into a series of guinea-pigs. That with which most of our experiments were conducted, had a minimum lethal dose of 0·12 c.c. per kilogram in 48 hours.

The antitoxins used were Behring's No. 1 and serum from the Pasteur Institute, Paris.

The constituent of the venom used was the one which is not destroyed by heating a solution of venom to 90° C. This constituent resembles most closely, if indeed it be not identical with, the principal constituent of cobra poison; and, as shown by one of us,† Calmette's antivenomous serum possesses a small but decided counteracting action upon it. This action, though unfortunately of little or no practical importance, is sufficient for our present purpose, for in our experiments we could mix comparatively large quantities of the serum with small fatal doses of the venom *in vitro*. Under these circumstances one could easily neutralise the poison.

The antitoxin was the antivenomous serum prepared by the Pasteur Institute at Lille, and bore date November, 1896.

We endeavoured at the outset to determine whether the action of antitoxins upon toxins were chemical or physiological, by a direct physical method. In 1896 one of us‡ published an account of a method of separating substances of large molecular size from those of smaller, in solutions containing both. This method was simply by filtering through a film of gelatin, supported in the wall of a Pasteur-Chamberland filter. The filtration was accomplished by a pressure of 50 atmospheres.

* 'Ann. de l'Inst. Pasteur,' 1895.

† C. J. M., 'Intercolonial Med. Journ. of Australasia,' August, 1897.

‡ C. J. M., 'Journal of Physiol.,' vol. 20, 1896.

A standardised solution of diphtheria toxin was filtered through such a filter. The filtrate was found to contain diphtheria toxin. This filtrate was then tested to ascertain whether it were as toxic as the original solution. As will be seen from the protocols it was somewhat diminished in toxic power (Protocol I).

The antitoxin of diphtheria, as was shown by Brodie,* does not pass through such a filter. When antitoxic serum is filtered through gelatin, the whole of the proteids, and together with them all antitoxic virtue, are absent from the filtrate (Protocol II). As the toxin is not held back by the filter, whereas the antitoxin is, one is provided with a simple physical means of separating them, *provided they have not reacted upon one another.*

We mixed a solution of toxin containing eight fatal doses per kilogram of guinea-pig in each c.c., with sufficient Behring's antitoxin to more than completely neutralise all the toxin. This mixture was allowed to remain *in contact at* 30° *C. for two hours*, and then filtered through the gelatin filter. Varying quantities of the filtrate were injected into guinea-pigs up to nearly 4 c.c. per kilogram of body weight, that is a quantity originally containing 32 fatal doses. The filtrate was quite innocent. The guinea-pigs suffered no inconvenience, and gained weight while under observation in small cages. The injections produced no local œdema.

If the toxin had remained unaffected beside the antitoxin there was nothing to prevent it passing through the filter in virtue of its relatively small molecular size. As, however, it did not do so, we can only conclude that it had entered into some sort of chemical relationship with the relatively large molecules of the anti-toxin during their sojourn together prior to filtration.

Having obtained results so definite, and in apparent contradiction to those of the authors quoted in the beginning of this paper, we next experimented with snake venom in order to repeat Calmette's† observations.

We took a series of rabbits (Protocol V) and injected them with mixtures containing one constituent of the venom of *Hoplocephalus curtus* and Calmette's antivenomous serum. On reference to the protocols of this series of experiments it is seen that 2 c.c. of this sample of serum was sufficient to counteract an amount of the poison contained in ·0002 gram of the dried venom. This amount killed control rabbits in about eight hours (Protocol IV).

In some of the experiments this amount of venom and serum was allowed to remain in contact for fifteen minutes at the laboratory temperature (21° C.) and then heated to 68° C. for ten minutes to destroy the antitoxin. In Calmette's experiments the rabbits

* 'Journ. of Path.,' 1897, p. 460.

† Calmette, *loc. cit.*

injected with this heated mixture died, whereas the controls injected with the mixture which had not been heated lived. From this he concluded that the serum and venom were merely existing side by side, and had not re-acted upon one another. In our experiments, on the contrary, the rabbits injected with the heated and unheated mixtures of venom and serum alike lived, nor did any of them suffer from symptoms such as loss of appetite, loss of weight, or diminished temperature. The only conclusion to be drawn from these experiments is that during the time which elapsed between the mixture of the venom and serum the latter had acted upon the former, so that there was no longer a fatal dose of venom present. The protocols will show that heating for ten minutes to 68° C. has no influence upon the venom. (P. VI, experiment 4.)

These results, while they lead to results in entire agreement with those drawn from the filtration experiments with diphtheria toxin and antitoxin, are diametrically opposed to the results obtained by Calmette. As the experiments are so simple as not to leave any possibility of experimental error, we turned our attention to any existing difference in the conditions under which Calmette and ourselves worked. As previously pointed out, Calmette absolutely neglected the possible influence of time, temperature, and the relative proportions of the active masses of the toxin and antitoxin present in his mixture. Up to the present we have investigated the value of the factors, time, and proportion of active masses, and have shown that these are most important. Indeed, by altering either the one or the other we can produce results which, if these factors be neglected, would lead to diametrically opposite conclusions.

The toxin and antitoxin of this venom are both of great molecular size and complexity. The former is a deutero-albumose and the latter probably a globulin,* or at any rate its molecular size is of the same order. *A priori* one would expect the velocity coefficient of any reaction between such complex molecules to be a high one, and in addition, from their great molecular weight, the solution will contain relatively few molecules: so that it is not surprising that any chemical operation in which they are concerned should occupy a very appreciable time.

The value of the factors time and influence of proportion of active masses will be best seen in reference to the table below, which is compiled from Protocols VII, VIII, IX, and represents the results of twenty-one experiments. On reading along any horizontal line will be seen the influence upon the result of the time during which the toxin and antitoxin were allowed to operate upon each other, with proportion of active masses constant. On reading any vertical line the influence of varying proportions of active masses with time

* Brodie, *loc. cit.*

of operation constant is indicated. The thick line separates off the fatal results from those in which the rabbits lived. All other factors were kept constant. The solutions were mixed in the varying proportions and stood at laboratory temperature (20—23° C.). At stated intervals, by a stop watch, portions were pipetted off, and the reaction terminated by rapidly raising the temperature to 68° C. in a water bath. They were kept at this temperature for 10 minutes, cooled, and kept for injection.

Proportion of toxin to antitoxin per kilo.		Control venom only.	Time allowed for interaction of toxin and antitoxin, temp. 20—23° C.					
Anti-toxin.	Toxin.		2 mins.	5 mins.	10 mins.	15 mins.	30 mins.	Injected unheated ∞ mins.
1 c.c.	2 fatal doses.	Died 15 hours.	Lived (very ill for 2 days)	Lived (ill 1 day).	Lived (no symptoms).	Lived (no symptoms).	Lived (no symptoms).	Lived (no symptoms).
1 c.c.	3 fatal doses.	Died 12 hours.	Died 20 hours.	Died 28 hours.	Lived (ill 2 days).	Lived (ill 1 day).	Lived (no symptoms).	Lived (no symptoms).
1 c.c.	4 fatal doses.	Died 9 hours.	Died 13 hours.	Died 15 hours.	Died 23 hours.	Lived (very ill 2 days).	Lived (no symptoms).	Lived (no symptoms).

In our experiments with diphtheria we allowed abundance of time, 2 hours, for the reaction between the toxin and antitoxin to take place. The surplus of antitoxin was also large, so that the active masses were considerable and the temperature was favourable, viz. 30° C. (Protocol III). We have not yet determined the influence of temperature upon the rapidity of the reaction, but our results so far seem sufficiently conclusive to decide the question and leave no room for doubt that the antagonism between the toxins of diphtheria and snake venom and their relative antitoxin is due to a direct chemical action which takes place between them. Further, that the opposite conclusion come to by Calmette, and presumably those of Wassermann, Nikanarow, and Marenghi were due to their disregard of the value of time as a factor in such chemical action.

Protocols.

A. Experiments with Diphtheria Toxin.

I. *Experiments to ascertain whether the Toxin of Diphtheria passes through a Gelatin Filter.*

The toxins were prepared by the method stated above and filtered through a Pasteur-Chamberland filter to free them from bacilli. The minimal fatal dose calculated for one kilogram weight of guinea-pig was 0·12 c.c. of toxin No. 1, and 0·6 c.c. of toxin No. 2. Portions of each of these toxins were filtered through gelatin and afterwards injected into guinea-pigs. As seen below the filtrates in each case contained toxin, but in less amount than the original solutions.*

Toxin No. 1.

	Amount injected.	Weight of animal in grams.	Result.
Before filtering through gelatin	0·25 c.c.	562	Died under 36 hours.
,, ,,	0·5 ,,	540	,, ,,
,, ,,	1·0 ,,	655	,, ,,
After filtering through gelatin	0·12 ,,	187	,, in 41 hours.
,, ,,	0·24 ,,	176	,, in 30 hours.

Toxin No. 2.

	Amount injected.	Weight of animal in grams.	Result.
Before filtering through gelatin	0·5 c.c.	377	Died in 56 hours.
After filtering through gelatin	0·5 ,,	275	,, 72 hours.

* This small diminution in toxic power by filtration may possibly be due to the action of oxygen at high tension (50 atmospheres of compressed air) or to the size of the toxin molecule being of the order of the molecular size of albumoses. Albumoses, as shown by one of us ('J. Physiol.,' 1896), pass through gelatin, but less readily than water, and the filtrate is accordingly less concentrated than the original solution.

II. *Experiments to confirm Brodie's* statement that the Antitoxin of Diphtheria does not pass through a Gelatin Filter.*

0·5 c.c. of Pasteur Institute antitoxin was mixed with 1 c.c. of toxin No. 1 (=8 fatal doses per kilo.), and injected into a guinea-pig weighing 260 grams.

The animal remained well and gained 26 grams during the four days it was kept under observation. The same sample of antitoxin was passed through the filter. Of the filtrate 0·6 c.c. was mixed with 0·6 c.c. of the same toxin and injected into a guinea-pig weighing 163 grams. The animal died in 22 hours.

III. *Experiments to show that when Diphtheria Toxin is mixed with Diphtheria Antitoxin in sufficient quantity, and allowed to remain in contact for a sufficient time, the filtrate which has passed through a Gelatin Filter is free from Toxin.*

60 c.c. of toxin No. 1 (containing approximately 500 lethal doses per kilogram) was mixed with 2·5 c.c. of Behring's antitoxin (= 600 units). The two were well mixed and allowed to stand at 30° C. for two hours before filtration.

The filtrate was injected subcutaneously into guinea-pigs as under:—

Weight in grams.	Amount injected.	Amount per kilo. of body weight.	Result.
400	1·0 c.c.	2·5 c.c. = 20 fatal doses	No symptoms.
340	1·25 ,,	3·6 c.c. = 30 ,,	,, ,,
318	1·25 ,,	3·9 c.c. = 32 ,,	,, ,,

The animals were absolutely unaffected. They never failed in appetite, nor was there any local œdema.

B. Experiments with Snake Venom.

IV. *Experiments to determine the Minimal Fatal Dose of the Poison used.*

The venom employed was that of *Hoplocephalus curtus*. This had been procured free from admixture with saliva by making the reptiles bite into a watch-glass covered with thin rubber sheeting. The liquid poison was rapidly dried at ordinary temperatures (15—20° C.) over calcium chloride, powdered, and stored in a stoppered bottle.

* *Loc. cit.*

All weights of venom mentioned below refer to this dried venom. About 2—3 milligrams were weighed out for each experiment and dissolved in 0·9 per cent. NaCl solution, so that 1 c.c. contained 0·0001 gram of dried venom.

The solution was then heated momentarily to 90° C. in order to destroy one of the poisonous constituents of the venom of this snake, a proteid which coagulates at 85° C.* This was done because Calmette's serum possesses little or no immunising action against this constituent.†

In all our experiments the same sample of venom was used, and it was treated in the way described above. The injections were always made subcutaneously into the flank.

Animal.	Weight in grams.	Amount of original venom per kilo. of body weight in grams.	Result.
Rabbit....	1360	0·0004	Died in 5 hours.
,, ...	1020	0·0002	,, 8 ,,
,, ...	910	0·0002	,, 9 ,,
,, ...	1250	0·00016	,, 10 ,,
,, ...	1705	0·00015	,, 10 ,,
,, ...	1250	0·0001	,, 10 ,,
,, ...	1240	0·00008	,, 12 ,,
,, ...	1030	0·000075	,, 10 ,,
,, ...	1220	0·00005	,, 16 ,,
,, ...	1370	0·000036	,, 24 ,,
,, ...	1300	0·00003	,, 48 ,,
,, ...	1380	0·00003	Lived. Very ill 3 days.
,, ...	1820	0·0000275	Died in 24 hours.
,, ...	1430	0·000025	,, 3 days.
,, ...	1140	0·00002	Lived. Very ill 3 days.
,, ...	1300	0·00002	,, ,,

From the above series it appears that 0·000025 gram per kilo. of body weight is about the lowest fatal dose. In the present paper, in speaking of so many fatal doses, this has been taken as the unit.

V. *Experiments to ascertain the value of Calmette's Serum in counteracting the Poison after it had been deprived by Heat of One Constituent.*

The solution of venom was prepared as in Series III. Calmette's serum bore date November, 1896. The two were mixed together in varying proportion, as stated below, and allowed to remain at

* C. J. M., 'Proc. Roy. Soc., N.S.W.,' August, 1896.

† C. J. M., 'Intercol. Med. J.,' August, 1897.

laboratory temperature (23° C.) for fifteen minutes. They were injected subcutaneously in amounts corresponding to the body weight of the animal.

Animal.	Weight in grams.	Amount of venom in grams per kilo.	Amount of serum in c.c. per kilo.	Result.
		= 16 fatal doses.		
Rabbit....	1350	0·0004	None	Died 5 hours.
,, ...	1370	0·0004	0·25	,, 6 ,,
,, ...	1330	0·0004	0·5	,, 10 ,,
,, ...	1370	0·0004	1·0	,, 12 ,,
,, ...	1375	0·0004	1·5	,, 16 ,,
		= 8 fatal doses.		
,, ...	1240	0·0002	1·0	,, 38 ,,
,, ...	1220	0·0002	1·5	Lived. 111 2 days.
,, ...	690	0·0002	2·0	,, No symptoms.
,, ...	1380	0·0002	3·0	,, ,, ,,

2 c.c. of the serum completely counteracts 0·0002 gram of the venom deprived of one of its constituents.

VI. *Experiments to determine whether mixture of venom and serum (in such proportions as to completely deprive the former of any toxic properties), regained toxic properties after destroying the antitoxin by heating to* 68° *C. per* 10 *minutes, subsequent to admixture.*

The venom solution and serum were mixed in the proportion of 1 c.c. of serum to every 0·0001 gram of venom. This proportion was found by the previous series of experiments to be adequate. The two solutions were mixed together, and allowed to remain 30 minutes at a temperature of 23°—24° C., after which the mixture was heated to 68° C. for 10 minutes to destroy the antitoxin. They were then cooled and injected subcutaneously in varying quantities per kilogram weight of the animal. The injections had no effect upon the animals, although they contained originally eight fatal doses of venom. This must therefore have been neutralised by the antitoxin during the time which elapsed before its destruction by heat.

Animal.	Weight in grams.	Amount of venom per kilo.	Amount of serum per kilo.	Result.
i. Rabbit...	1140	0·0002	3 c.c.	Lived. No symptoms.
ii. ,, ...	710	0·0002	2 ,,	
iii. ,, ...	1210	0·0003	3 ,,	
*iv. ,, ...	1020	0·0002	None	Died in 9 hours.
v. ,, ...	1160	0·0002	None	,, 8½ ,,

VII. *Experiments to determine the influence of variations in the time during which venom, and antivenomous serum, operated upon one another.*

In this series of experiments, the same samples of venom and serum were employed as before. The relative proportions of the two were kept constant. The venom solution and serum were mixed together in the proportion of 0·0001 gram of venom to 1 c.c. of the serum and well stirred. After they had remained in contact at the temperature of the laboratory (21° C.) for times varying from 2 to 30 minutes, portions were pipetted off, and rapidly raised to 68° C., at which temperature they were kept for 10 minutes. The portions were then rapidly cooled, and injected subcutaneously in quantities proportionate to the body weights of the animals. Amounts of venom and of serum equivalent to 0·0001 gram and 1 c.c. respectively per kilogram of body weight were injected in each case, except the control, when this quantity of venom was employed.

Animal.	Weight in grams.	Time during which venom and serum were in contact before heating.	Results.
i. Rabbit....	1370	Venom only (control)	Died in 9 hours.
ii. ,, ...	1320	2 minutes	,, 13 ,,
iii. ,, ...	1340	5 ,,	,, 15 ,,
iv. ,, ...	1400	10 ,,	,, 23 ,,
v. ,, ...	1220	15 ,,	Lived. Very ill for 2 days.
vi. ,, ...	1160	30 ,,	,, No symptoms.
vii. ,, ...	890	Not heated at all	,, ,, ,,

* In Experiment No. IV no serum was mixed with the venom, but the venom solution was heated alone to 68° C. for 10 minutes to show that this treatment has no influence upon it.

VIII.—*Similar to* VII, *except that the preponderance of Antitoxin was greater, viz.*, 0·000075 *gram of venom and* 1 *c.c. of serum per kilogram of body weight in each case.*

Animal.	Weight in grams.	Time during which venom and serum were left in contact before heating.	Results.
i. Rabbit....	1025	Venom only (control)	Died in 12 hours.
ii. ,, ...	1190	2 minutes	,, 20 ,,
iii. ,, ...	1130	5 ,,	,, 28 ,,
iv. ,, ...	1060	10 ,,	Lived. Very ill 2 days.
v. ,, ...	1250	15 ,,	,, Ill 1 day.
vi. ,, ...	1210	30 ,,	,, No symptoms.
vii. ,, ...	1070	Not heated at all	,, ,,

IX.—*Similar to* VII *and* VIII, *but the preponderance of Serum is still greater, viz.*, 0·00005 *gram of venom and* 1 *c.c. of serum per kilogram of body weight in each case.*

Animal.	Weight in grams.	Time during which venom and serum were in contact before heating.	Result.
i. Rabbit....	1070	Venom only (control)	Died in 15 hours.
ii. ,, ...	1200	2 minutes	Lived. Very ill for 2 days.
iii. ,, ...	1170	5 ,,	,, Off feed 1 day.
iv. ,, ...	1130	10 ,,	,, No symptoms.
v. ,, ...	1030	15 ,,	,, ,,
vi. ,, ...	1420	30 ,,	,, ,,
vii. ,, ...	1050	Not heated at all	,, ,,

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"On the Source of the Röntgen Rays in Focus Tubes." By ALAN A. CAMPBELL SWINTON. Communicated by Lord KELVIN, F.R.S. Received June 7,—Read June 16, 1898.

The writer has already described ("Some new Studies in Cathode and Röntgen Radiations," a discourse given at the Royal Institution on February 4, 1898) how he has found it possible to study by means of pin-hole photography the active area on the anti-cathode of a focus tube from which the Röntgen rays proceed.